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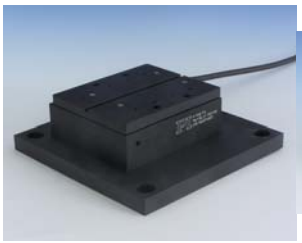
MP 74E User Manual

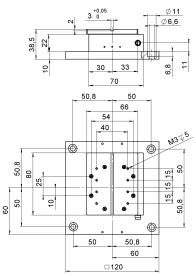
V-106 Voice Coil Micropositioners

Release: 1.1.0 Date: 2006-12-04

This document describes the following product(s):

- V-106.11S
  Voice Coil Micropositioners, 6 mm Travel Range
- V-106.14S
  Voice Coil Micropositioners, 20 mm Travel Range





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Declaration of Conformity

according to ISO / IEC Guide 22 and EN 45014

Manufacturer: **Physik Instrumente (PI) GmbH & Co. KG**
Manufacturer´s Address: Auf der Römerstrasse 1, D-76228 Karlsruhe, Germany

CE

The manufacturer hereby declares that the product

Product Name: **Voice Coil Micropositioner**
Model Numbers: **V-106.11S, V-106.14S**
Product Options: **all**

conforms to the following EMC Standards and normative documents:

Electromagnetic Emission:	EN 61000-6-3, EN 55011
Electromagnetic Immunity:	EN 61000-6-1
Safety (Low Voltage Directive):	EN 61010-1
Safety of Machinery:	EN 12100

November 14, 2006
Karlsruhe, Germany

Dr. Karl Spanner
President

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About this Document

Users of this Manual

This manual is designed to help the reader to install and operate the V-106 Voice Coil Micropositioners. It assumes that the reader has a fundamental understanding of basic servo systems, as well as motion control concepts and applicable safety procedures.
The manual describes the physical specifications and dimensions of the V-106 Voice Coil Micropositioners as well as the software and hardware installation procedures which are required to put the associated motion system into operation.
This document is available as PDF file on the product CD. Current releases can be downloaded from the PI Website as PDF files (www.pi.ws), obtained from your Physik Instrumente sales engineer or from info@pi.ws

Conventions

The notes and symbols used in this manual have the following meanings:

WARNING

Calls attention to a procedure, practice or condition which, if not correctly performed or adhered to, could result in injury or death.

CAUTION

Calls attention to a procedure, practice, or condition which, if not correctly performed or adhered to, could result in damage to equipment.

!

NOTE

Provides additional information or application hints.

Related Documents

The motion controller and the software tools which might be delivered with V-106 Voice Coil Micropositioners are described in their own manuals. All documents are available as PDF files on the Motion CD or special product CD. Updated releases are available from the PI Website as PDF files (www.pi.ws), from your Physik Instrumente sales engineer or from info@pi.ws

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1 Introduction

QuickScan™micropositioning stages of the V-106 series are designed for high-dynamics precision scanning and positioning applications, like those in biotechnology and fiber optics. They are based on zero-friction voice coil drives (linear motors), which, combined with high-precision linear encoders, offer a minimal step size of 0.2 µm.

High-accuracy voice coil linear drives work on the same principle as electromagnetic loudspeakers. However, for precision positioning applications they must provide much higher forces and have high stability to hold a position without jitter. They must also be designed for closed-loop operation to allow for precise positioning.

V-106 micropositioning stages achieve significantly higher dynamics than leadscrew-based units. The specially designed voice coil drive system makes possible scanning frequencies of some tens of hertz. With an applied load of 90 grams, the scan frequency still is 20 Hz over a travel range of 1 mm. The excellent dynamic characteristics are advantageous not only for scanning applications: positioning tasks see them as short settling times, like 75 ms for 5 mm with a 90-gram load.

1.1 Direct Drive and Direct Metrology—Precise Motion

The design of the V-106 is based on three key precision components:

- A frictionless voice coil (linear motor) drive
- A non-contacting, direct-motion-metrology linear encoder for sub-micron repeatability
- Precision cross-roller bearings for ultra-straight and -smooth motion

Unlike leadscrew-driven translation stages, the voice coil linear motor in the V-106 is quiet, frictionless, and not subject to wear and tear. In addition, it provides higher dynamics, speed, acceleration and responsiveness (step-and-settle).

For highly repeatable motion, a non-contacting optical linear encoder with 0.1 µm resolution is mounted inside the stage and feeds position information back to the motion controller.

1.2 Convenient Control

V-106 voice coil stages can be controlled by the C-843 digital contoller in PCI plug-in-board format. C-843 controllers are equipped with on-board linear servo-amplifiers for precise control of up to four axes. This lowers system costs and simplifies setup by eliminating additional external amplifiers and cables.

1.3 Safety Precautions

Read this before operating the voice coil micropositioner.

CAUTION

Be aware that overlength mounting screws will interfere with motion and may cause permanent damage!

CAUTION

Be aware that the stage could start an unexpected move when first connected to the motor controller.

1.4 Features

- Fast Scanning and Positioning
- Speed up to 270 mm/s
- Travel Ranges of 20 mm and 6 mm
- Resolution to 0.1 µm
- Scanning Frequency to 34 Hz
- Crossed Roller Bearings for Highest Reliability
- Compatible with PI C-843 PCI-Bus PC-Board Controller

1.5 Model Survey

- V-106.11S 120 x 120 mm footprint (80 x 70 mm without baseplate) with travel range of yyy
- V-106.14S 120 x 120 mm footprint (80 x 127 mm without baseplate) with travel range of 20 mm

Fig. 1: V-106.11S (left) and V-106.14S (right)

The recommended controller, the C-843 PCI card, is available in 2- and 4-axis versions, and must be ordered separately.

Earlier V-106 versions, V-106.1S and V-106.2S, as well as the V-820.20 controller board, are no longer available and are not covered in this manual.

1.6 Prescribed Use

Correct operation of the V-106 positioners is only possible in combination with a suitable controller/driver (ordered separately) and software.
The controlling device must be able to read out and process the signals from the reference switch and incremental position encoder to ensure proper performance of the servo-control system.

Based on their design and realization, the V-106 stages are intended for single-axis positioning, adjusting and shifting of loads at various velocities. To achieve the specified guiding accuracy, the positioners have to be mounted on a flat surface to avoid torsion of the basic profile.

The positioners may only be used for applications suitably in accordance with the device specifications.

Respect the safety instructions given in this User Manual. The operator is responsible for the correct installation and operation of the V-106.

The verification of the technical specifications by the manufacturer does not imply the validation of complete applications. In fact the operator is responsible for the process validation and the appropriate releases.

V-106s meet the specifications of EN 61010 for safe operation under normal ambient conditions. See the specifications table on p. 13 for details.

1.7 Unpacking

1.7.1 Contents of Delivery

Unpack the V-106 stage with care. Compare the contents against the items covered by the contract and against the packing list.

Inspect the contents for signs of damage. If parts are missing or you notice signs of damage, such as loose contacts or hairline cracks, please contact PI immediately.

1.7.2 Transport Lock

Before operation, the transport lock must be removed (see Fig. 2 below). Save the transport lock hardware and all packaging materials in case the stage needs to be transported again.

Fig. 2: Removing transport lock

2 Installation

2.1 Mechanical Mounting

To avoid exceeding the load limits, the stage is usually mounted horizontally, with the application attached using the threaded mounting holes in the top platform.

CAUTION

Overlength mounting screws will interfere with motion and may cause permanent damage!

!

It is possible to operate the V-106 without the baseplate and/or the top platform if desired.

A Torx #8 driver is required to remove the attachment screws (4 each). The screws which attach the baseplate to the body are accessible through clearance holes in the attached top platform when it is properly positioned.

Tighten screws alternately to avoid stress and deformations. Operation with the top platform removed reduces the moved mass and thus increases the available acceleration and bandwidth. Be sure to prevent contamination of, or damage to, the delicate drive mechanism.

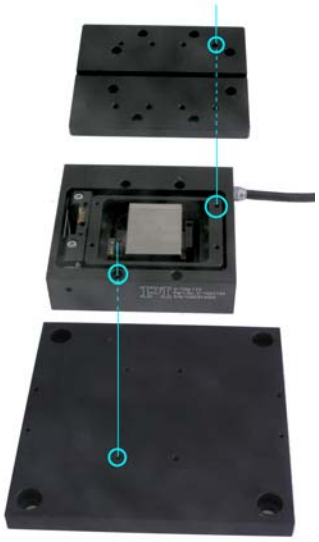


Fig. 3: V-106.11S with top and bottom plates removed, each held by four screws. Two sets of matching holes are circled.

2.2 Host PC and Controller

Voice Coil Micropositionerss can be connected to current C-843 2- and 4-axis controllers (C-843.21, C-843.41). These controllers are PCI-bus add-on PC boards and must be installed inside the host PC. See the C-843 User Manual for

instructions explaining the installation of the controller, its software and drivers. The controller User Manual also provides an overview of the software interfaces provided for operators and programmers, each of which is then described in detail in its own software manual.

With proper configuration, other positioning devices may be operated on other axes of the same controller at the same time.

3 Operational Considerations

3.1 Direction of Motion

The low end of the travel range is the end that is approached with negative relative moves. It is shown in Fig. 4 and is the same for both standard versions.

Fig. 4: V-106 at low end of travel range

3.2 Limit Switches

V-106.11S and V-106.14S stages do not have limit switches. The limit switch lines are tied to ground.

3.3 Reference Switch

All versions are equipped with a direction-sensing Hall-effect reference switch. This switch provides a TTL signal which is high when the platform is on the positive side of the reference point (which is close to the center of the travel range). Except for the small hysteresis zone, the reference signal is always low on the negative side.. Because of the hysteresis, it is important to always approach the reference switch from the same side. PI's GCS (General Command Set) referencing commands will go past the reference point if necessary so as to approach it from the negative side. See the controller User Manual and/or associated software manuals for the commands which make use of the reference signal.

3.4 Incremental Position Sensor

V-106 stages are equipped with incremental position sensors, called encoders. These sensors provide highly accurate signals whenever the position changes by a known, small amount. By counting the encoder signals, called *counts*, the controller can keep track of the relative motion of the stage. To discover the absolute position, it is necessary to drive the stage to the reference switch. Most controllers have commands to automate this procedure, which is usually called *referencing*.

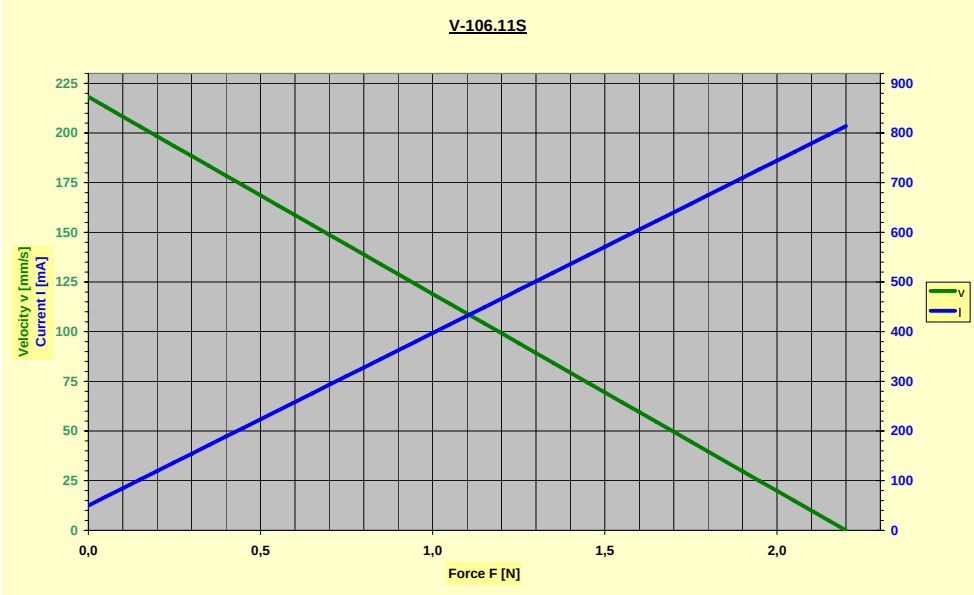
3.5 Operation

To operate the stage, proceed as follows:

1. Install the C-843 controller following the instructions in the controller manual.
2. Install the host software in the host computer. This procedure is described in the accompanying software manual.
3. Connect the stage to the controller using the cable permanently attached to the stage
4. Command a few test moves to make sure everything is working properly.

4 Performance

4.1 Drive Characteristics



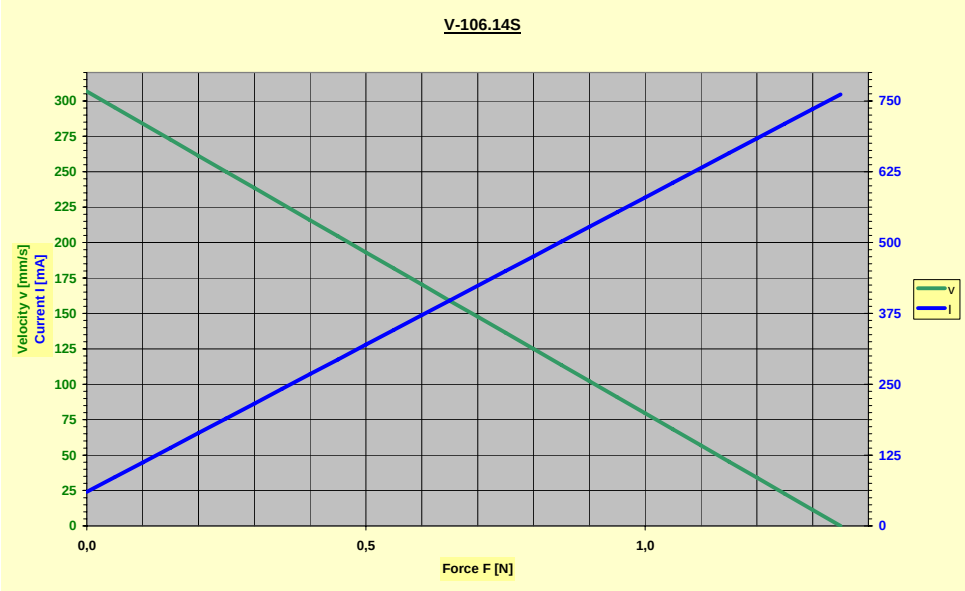


Fig. 5:V-106.11S and V.-106.4S drive characteristics[*]

[*] In practice, the max. velocity of the stage is limited by the encoder sampling to 270 mm/s

4.2 Maximum Velocity vs. Load

Measured over a 5 mm / 18 mm step with additional loads of 0 g, 36 g (V-106.11S only), 90 g and 350 g (V-106.14S only). The acceleration was chosen so as to keep the tracking error less than approx. +/-25 µm.

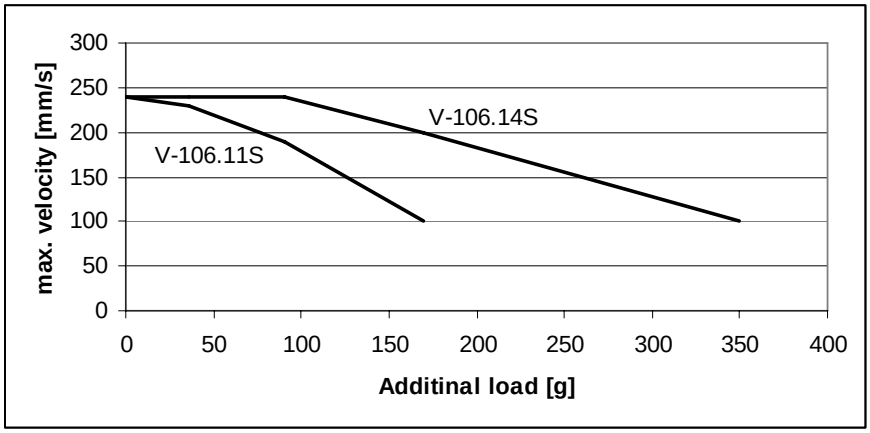


Fig. 6:Maximum velocity vs additional load

4.3 Maximum Operating Frequency vs. Load

Measured over total scanning ranges of 1 mm, 5 mm and 18 mm (V-106.14S only), with additional loads of 0 g, 36 g (V-106.11S only) and 90 g.

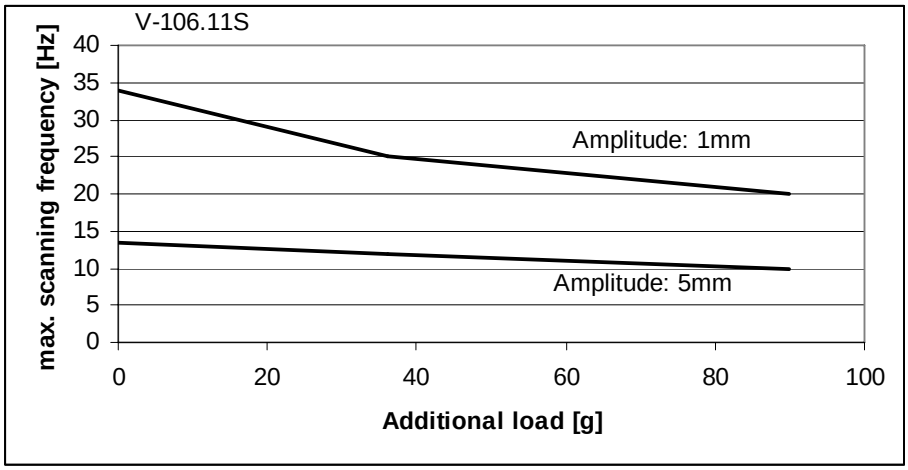
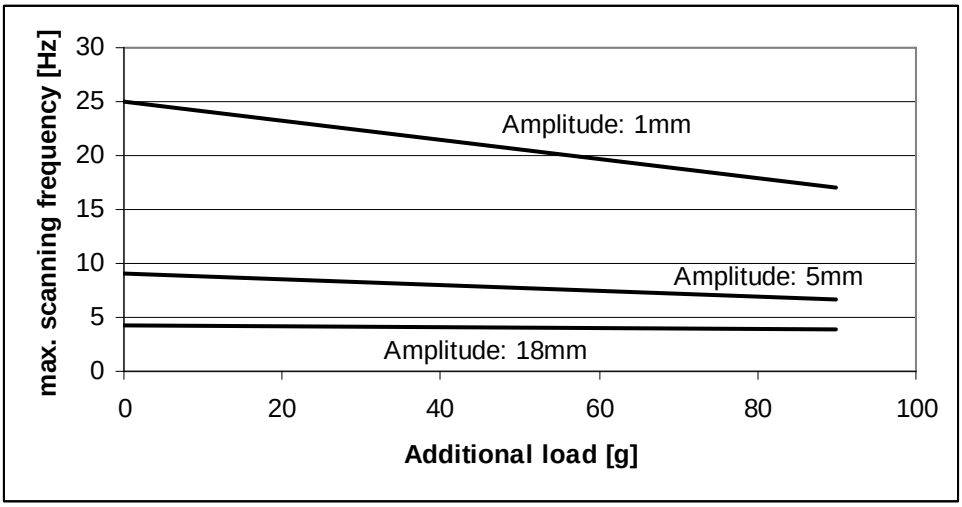


Fig. 7:V-106.11S maximum operating frequency vs additional load

For the V-106.14S the results are follows:



The mass of the moving platform (including part of the drive) is 102 g for the V-106.11S and 171 g for the V-106.14S.

NOTE

Voice coil drives only allow an average current of 0.42 A (see appendix) during long-duration operation. The maximum operating frequency for such operation is therefore only half the short-term maximum!

5 Technical Data

5.1 Specifications

Models	V-106.11S	V-106.14S	Units	Tolerance
Active axes	1	1		
Motion and Positioning				
Travel range	6	20	mm	
Integrated sensor	Linear encoder	Linear encoder		
Sensor resolution	0.1	0.1	µm	
Minimum incremental motion	0.2	0.2	µm	Typ. A3
Backlash	0.2	0.2		
Unidirectional repeatability	0.2	0.2	µm	Typ. A4
Pitch	50	50	µrad	Typ.
Yaw	50	50	µrad	Typ.
Max. velocity*	240	270	mm/s	
Ref. switch repeatability	1	1	µm	Typ.
Mechanical Characteristics				
Moved mass	102	172	g	Typ.
Load	36	81	N	B1
Push/pull force**	5	3.3	N	B2
Push/pull force with C-843**	2.3	1.5	N	B2
Lateral force	18	40	N	Max.
Drive properties				
Drive type	Voice coil	Voice coil		
Continuous average current	0.42	0.42	A	nominal
Peak current	1.8	1.8	A	max. (3s)
Average force	1.2	0.8	N	nominal
Coil resistance	10	10		typ.
Coil inductance	100	100	µH	typ.
Force constant	2.88	1.92	N/A	
Voltage generation constant	36.1	24	Vs/m	
Miscelaneous				

Operating temperature range	0 to 55	0 to 55	°C	
Body material	Aluminum	Aluminum		
Mass (without cable)	800	1000	g	+/-5%
Cable length	300	300	mm	+/- 10 mm
Connector	Sub-D 15m	Sub-D 15m		
Recommended controller/driver	C-843	C-843		

* with C-843.x1 controller; limited by controller's encoder counting rate; V-106.11S and V-106.14S are equipped with 5 MHz AB quadrature encoders.
** The C-843.x1 provides a maximum of 8 V and 0.8 A per channel, and therefore limits the push/pull force.

NOTES
A3
Design Resolution: The theoretical minimum movement that can be made based on the selection of the mechanical drive components. Design resolution is usually better than the practical position resolution (minimum incremental motion).
A4
Minimum Incremental Motion: The minimum motion that can be repeatedly executed for a given input, which is sometimes referred to as practical or operational resolution. Design resolution and practical resolution have to be distinguished.
B1
Max. Normal Load Capacity: Centered, vertical load (horizontal installation).
B2
Max. Push/Pull Force: Active and passive force limit in operating direction, at center of stage. Some stages may be able to generate higher forces at the cost of reduced lifetime.

5.2 Controller Details

Each stage in the motion system must be connected to a motion controller. The controller is either preprogrammed for stand-alone operation or networked with or installed in a PC: i.e. controller setup and/or operation are effectuated with software. V-106 stages are usually operated with C-843 controllers, but are compatible with other controllers designed to operate DC motors. In general the full capabilities of the stage will not be available with any given controller.

NOTE

Most standard controllers from PI use a DAT file which contains information on all PI standard micropositioners and installs automatically with the host software. This file, called pistages.dat, also includes an initial set of PID servo-control parameters for each stage type. In case your

controller does not use pistages.dat, possible PID parameters are included in this manual.

5.2.1 C-843 DC-Motor Controller

The C-843.21 (2-axis) and C-843.41 (4-axis) are the recommended controllers for the V-106. When used with PIMikroMove® software, appropriate starting settings are taken from the stages database file PIStages.dat. See the PIMikroMove® manual for more details.

5.2.2 C-862 Mercury™ DC-Motor Controller

The C-862 Mercury™ controller* is a compact palm-size single-axis controller. C-862s are daisy-chain networkable and a multi-axis system can be controlled from a single PC RS-232 interface.

Mercury™ controllers come with a choice of user interface software, not all of which uses pistages.dat. If you use *MMCRun* the following values should be used for operating voice coil stages.

Mercury™ Starting Parameters
for V-106.11S & V-106.14S

Parameter	Recommended Value	Minimum Value	Maximum Value
p-term	50	10	100
i-term	100	0	200
d-term	220	0	500
i-limit	2000	0	2000
Velocity [cts*/s]	250,000	0	500,000
Velocity [mm/s]	25	0	50
Acceleration [cts*/s²]	3,000,000	10,000	30,000,000
Acceleration [m/s²]	0.3	0.001	3.0

* cts = encoder counts

Both V-106.11 and V-106.14 scanners can be operated with the same parameter settings. The settings given are recommended values only, and might not fit your specific application.

5.2.3 Other Controllers

If using a third-party controller, or a PI controller with software that does not have V-106 data in a stage database, read the controller documentation carefully and compare with the V-106 specifications given in this manual. Considerable experimentation may be necessary.

6 Connector Pinouts

Connector type: sub-D15(m)

Pin#	Function
1	n.c.
2	input: Motor(+)
3	internal use
4	input: +5V (Encoder and logic supply)
5	GND*
6	GND
7	output: Encoder A (inverted)
8	output: Encoder B (inverted)
9	input: Motor (-)
10	GND
11	internal use
12	GND*
13	output: Reference signal
14	output: Encoder A (standard)
15	output: Encoder B (standard)

*Lines 5 and 12 are reserved by the controller for negative-end and positive-end limit switch signals, respectively. Because the V-106.1xS have no limit switches, both lines are grounded at the stage.

7 Dimensions

Dimensions in mm, decimal places separated by commas in drawings.

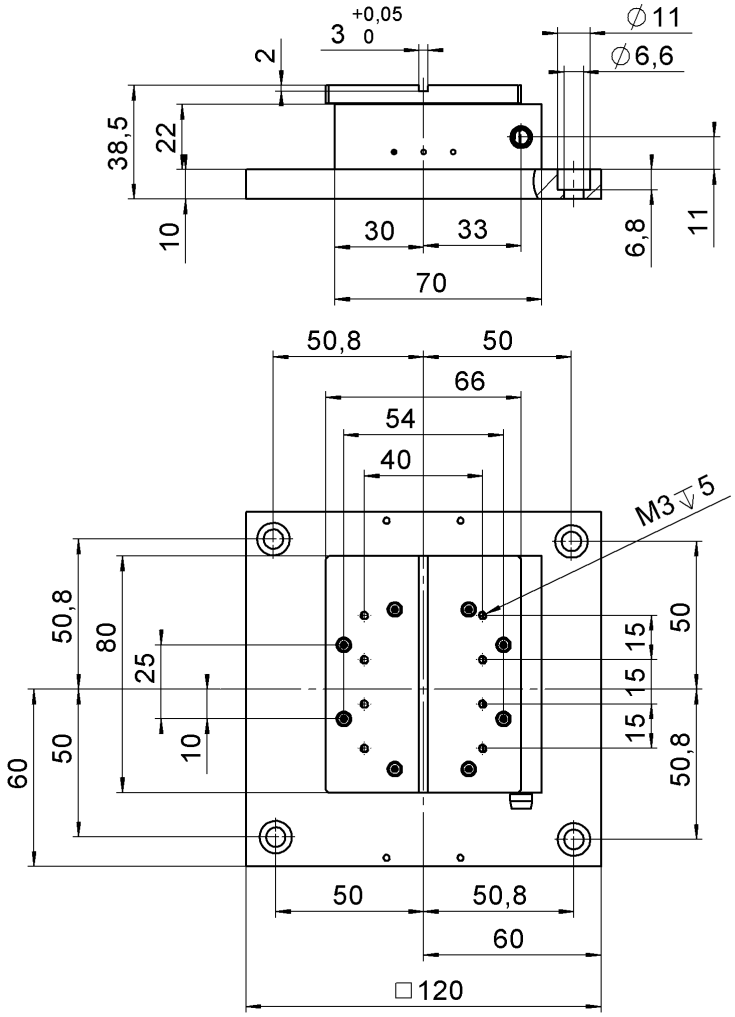


Fig. 8: V-106.11S dimensions

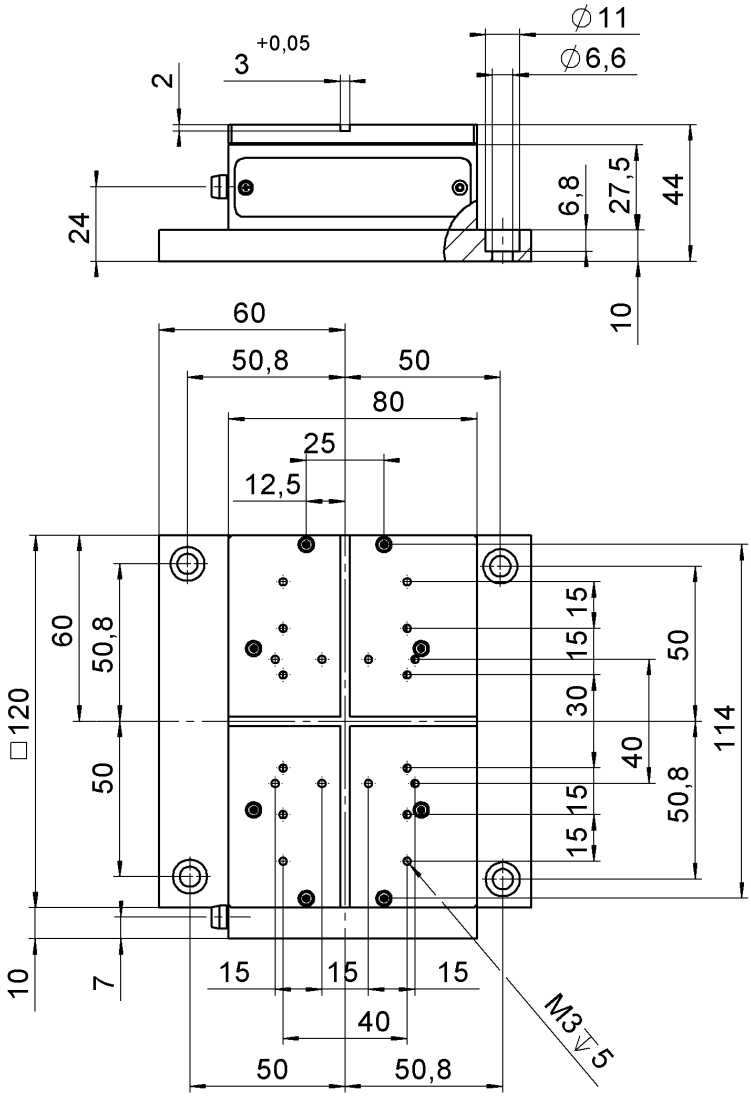


Fig. 9: V-106.14S dimensions